

CLAIMS

1. An adjustment method for a projection optical system which projects an image of a pattern on a first surface onto a second surface, comprising:
 - changing at least one condition of illumination condition for illuminating the pattern on the first surface and structural condition of the pattern in various ways;
 - changing a wavelength of illumination light for illuminating the pattern on the first surface for each condition, and detecting a change amount of image formation characteristics of an image projected onto the second surface via the projection optical system; and
 - determining a predetermined relationship between a change amount of installation environment of the projection optical system and the change amount of the image formation characteristics for each condition based on a result of the detection.
2. The adjustment method for a projection optical system according to Claim 1, wherein when the installation environment of the projection optical system changes, the image formation characteristics of the projection optical system is adjusted based on the predetermined relationship.
3. The adjustment method for a projection optical system according to Claim 2, wherein the image formation characteristics of the projection optical system are adjusted by changing the wavelength of the illumination light based on the predetermined relationship.
4. An adjustment method for a projection optical system which projects an image of a pattern on a first surface onto a second surface, comprising:
 - when assembling and adjusting the projection optical system at an assembly location, in case an environment of the assembly location where the projection

optical system is assembled and adjusted is different from an environment of a relocated location where the projection optical system is used,

changing a wavelength of an illumination light for illuminating the pattern on the first surface from a predetermined wavelength by an amount according to the environment of the relocated location in advance, and then assembling and adjusting the projection optical system under a condition of the changed wavelength; and

setting the wavelength to the predetermined wavelength when the projection optical system is used in the relocated location.

5. The adjustment method for a projection optical system according to Claim 2, wherein gas whose barometric pressure changes in association with the atmospheric pressure is supplied inside the projection optical system, and the change of the installation environment of the projection optical system is the change of the atmospheric pressure.

6. The adjustment method for a projection optical system according to Claim 1, wherein the predetermined relationship is determined based on the first relationship between the change amount of the installation environment and the change amount of the wavelength, and the second relationship between the change amount of the wavelength and the change amount of the image formation characteristics.

7. The adjustment method for a projection optical system according to Claim 6, wherein the first relationship is determined based on the refractive index characteristics of the glass material of the projection optical system and the refractive index characteristics of gas around the projection optical system.

8. The adjustment method for a projection optical system according to Claim 7, wherein the projection optical system is comprised of a plurality of types of glass materials, and the first relationship is determined by equalizing the relationship between

the change amount of the installation environment and the change amount of the wavelength determined for each one of the plurality of types of glass materials.

9. The adjustment method for a projection optical system according to Claim 1, wherein the change amount of the image formation characteristics due to the change of the wavelength of the illumination light is detected in a state where the installation environment of the projection optical system is maintained to be constant.

10. The adjustment method for a projection optical system according to Claim 4, wherein when the projection optical system is used in the relocated location, the wavelength of the illumination light is set to a wavelength according to the environment of the assembly location.

11. An exposure method for illuminating a pattern formed on a first surface by an illumination light and projecting an image of the pattern onto a second surface via a projection optical system, comprising:

a first step of determining information on a change amount of predetermined image formation characteristics of the projection optical system caused by a predetermined factor;

a second step of selecting at least one of a first technique for adjusting the predetermined image formation characteristics by changing a wavelength of the illumination light and a second technique for adjusting the predetermined image formation characteristics using a method different from the first technique; and

third step of correcting the change amount of the predetermined image formation characteristics caused by the predetermined factor using the at least one selected technique in the second step.

12. The exposure method according to claim 11, wherein in the first step, the change amount of the predetermined image formation characteristics is determined based

on the result of measurement of an installation environment of the projection optical system.

13. The exposure method according to Claim 12, wherein the change amount of the installation environment is the difference between the measured environment and a predetermined reference environment.

14. The exposure method according to Claim 11, wherein the second technique is the adjustment of the projection optical system.

15. The exposure method according to Claim 14, wherein the adjustment of the projection optical system is performed by a first adjustment for moving at least one lens of the projection optical system in the optical axis direction of the projection optical system or inclining the lens with respect to the optical axis, or by a second adjustment for controlling the barometric pressure in a space sealed between a predetermined part of lenses of the projection optical system.

16. The exposure method according to Claim 11, wherein in the first step, the change amount of the predetermined image formation characteristics caused by a factor other than the installation environment of the projection optical system is determined.

17. The exposure method according to Claim 16, wherein the change amount of the predetermined image formation characteristics caused by a factor other than the installation environment includes the fluctuation of the predetermined image formation characteristics due to the irradiation of the illumination light.

18. The exposure method according to Claim 11, wherein the projection optical system is comprised of a plurality of types of glass materials.

19. The exposure method according to Claim 18, wherein in the second step, both the first technique and the second technique are selected, and in the third step, the residue of the change amount of the predetermined image formation characteristics which

the first technique could not completely correct is corrected by the second technique after executing the first technique.

20. The exposure method according to Claim 12, wherein when the change amount of the installation environment is greater than or equal to a predetermined value, the first technique is selected in the second step.

21. An exposure method using a projection exposure apparatus for illuminating a pattern formed on a first surface by an illumination light and projecting an image of the pattern onto a second surface via a projection optical system, comprising:

measuring an installation environment of the projection optical system to determine a change amount of the installation environment, and

changing a wavelength of the illumination light according to the change amount of the installation environment while the projection exposure apparatus is executing a predetermined preparation operation for projecting the image of the pattern onto the second surface.

22. The exposure method according to Claim 21, wherein the predetermined preparation operation includes at least one operation among operations of setting a mask on which the pattern is formed at a predetermined position for exposure in the projection exposure apparatus; of setting a substrate onto which the image of the pattern is projected at a predetermined exposure position in the projection exposure apparatus, and of specifying the illumination area of the illumination light on the mask.

23. A device manufacturing method comprising transferring the device pattern onto a work piece using the exposure method according to Claim 11.

24. A projection exposure apparatus comprising an illumination optical system which illuminates a mask pattern by an illumination light, and a projection optical system which projects the image of the mask pattern onto a substrate, the apparatus comprising:

a wavelength adjusting device which changes a wavelength of the illumination light;

an image formation characteristics measurement system which measures a change amount of image formation characteristics of the projection optical system;

a control system which is electrically connected to the wavelength adjusting device and the image formation characteristics measurement system, changes at least one condition of illumination condition for illuminating the mask pattern and structural condition of the mask pattern in various ways, controls the formation characteristics measurement system to measure a change amount of the image formation characteristics while changing the wavelength by the wavelength adjusting device for each condition, and determines a predetermined relationship between a change amount of the installation environment of the projection optical system and the change amount of the image formation characteristics based on the measurement results for the each condition; and

a memory which is electrically connected to the control system and stores the predetermined relationship determined by the control system for the each condition.

25. A projection exposure apparatus comprising an illumination optical system which illuminates a mask pattern by an illumination light and a projection optical system which projects the image of the mask pattern onto a substrate, the projection exposure apparatus comprising:

a measurement device which determines information on a change amount of predetermined image formation characteristics of the projection optical system caused by a predetermined factor;

a first image formation characteristics adjustment system which is electrically connected to the measurement device and adjusts the predetermined image

formation characteristics by a first technique for changing a wavelength of the illumination light; and

a second image formation characteristics adjustment system which is electrically connected to the measurement device and adjusts the predetermined image formation characteristics by a second technique which is different from the first technique,

wherein at least one of the first image formation characteristics adjustment system and the second image formation characteristics adjustment system is selected, and the at least one selected system is used to correct the change amount of the predetermined image formation characteristics caused by the predetermined factor.

26. The projection exposure apparatus according to Claim 25, wherein the second image formation characteristics adjustment system adjusts the image formation characteristics by adjusting the projection optical system.

27. The projection exposure apparatus according to Claim 26, wherein the projection optical system is comprised of a plurality of types of glass materials.

28. The projection exposure apparatus according to Claim 27, wherein the projection exposure apparatus selects both the first image formation characteristics adjustment system and the second image formation characteristics adjustment system, and allows the second image formation characteristics adjustment system to adjust the residue of the change amount of the predetermined image formation characteristics which the first image formation characteristics adjustment system could not correct.

29. The projection exposure apparatus according to Claim 25, wherein the measurement device determines the change amount of the installation of the projection optical system as the information, and when the change amount of the installation environment is a predetermined value or more, the projection apparatus selects the first image formation characteristics adjustment system.

30. A projection exposure apparatus comprising an illumination optical system which illuminates a mask pattern by an illumination light, and a projection optical system which projects the image of the mask pattern onto a substrate, the projection exposure apparatus comprising:

a wavelength adjusting device which changes a wavelength of the illumination light; and

an installation environment measurement system which measures the installation environment of the projection optical system and determines a change amount of the installation environment,

wherein the wavelength adjusting device changes the wavelength of the illumination light according to the change amount of the installation environment while the projection exposure apparatus is executing a predetermined preparation operation for projecting the image of the pattern onto the substrate.

31. The projection exposure apparatus according to Claim 30, wherein the predetermined preparation operation includes at least one operation of the operations of setting the mask on which the pattern is formed at a predetermined position for exposure in the projection exposure apparatus, an operation for setting the substrate onto which the image of the pattern is projected at a predetermined exposure position in the projection exposure apparatus, and an operation for specifying an illumination area of the illumination light on the mask.

32. The adjustment method for a projection optical system according to Claim 3 wherein gas whose barometric pressure changes in association with the atmospheric pressure is supplied inside the projection optical system, and the change of the installation environment of the projection optical system is the change of the atmospheric pressure.

33. The adjustment method for a projection optical system according to Claim 4 wherein gas whose barometric pressure changes in association with the atmospheric pressure is supplied inside the projection optical system, and the change of the installation environment of the projection optical system is the change of the atmospheric pressure.

34. A device manufacturing method comprising transferring the device pattern onto a work piece using the exposure method according to Claim 21.

35. The exposure method according to Claim 12, wherein the second technique is selected in case that the change amount of the predetermined image formation characteristics determined in the first step is generated in a predetermined period of time.

36. The exposure method according to Claim 35, wherein the predetermined period of time is a period for processing one lot.

37. The exposure method according to Claim 17, wherein the first technique is selected in the second step.

38. The exposure method according to Claim 11, wherein the projection optical system is comprised of a single glass material, and the first technique is selected in the second step.

39. The projection exposure apparatus according to Claim 25, wherein the projection exposure apparatus selects the second image formation characteristics adjustment system in case that the change amount of the predetermined image formation characteristics determined by the measurement device is generated in a predetermined period of time.

40. The projection exposure apparatus according to Claim 25, wherein the predetermined factor is irradiation of the illumination light to the projection optical system,

and the projection exposure apparatus selects the first image formation characteristics adjustment system.

41. The projection exposure apparatus according to Claim 25, wherein the projection optical system is comprised of a single glass material, and the projection exposure apparatus uses the first image formation characteristics adjustment system.